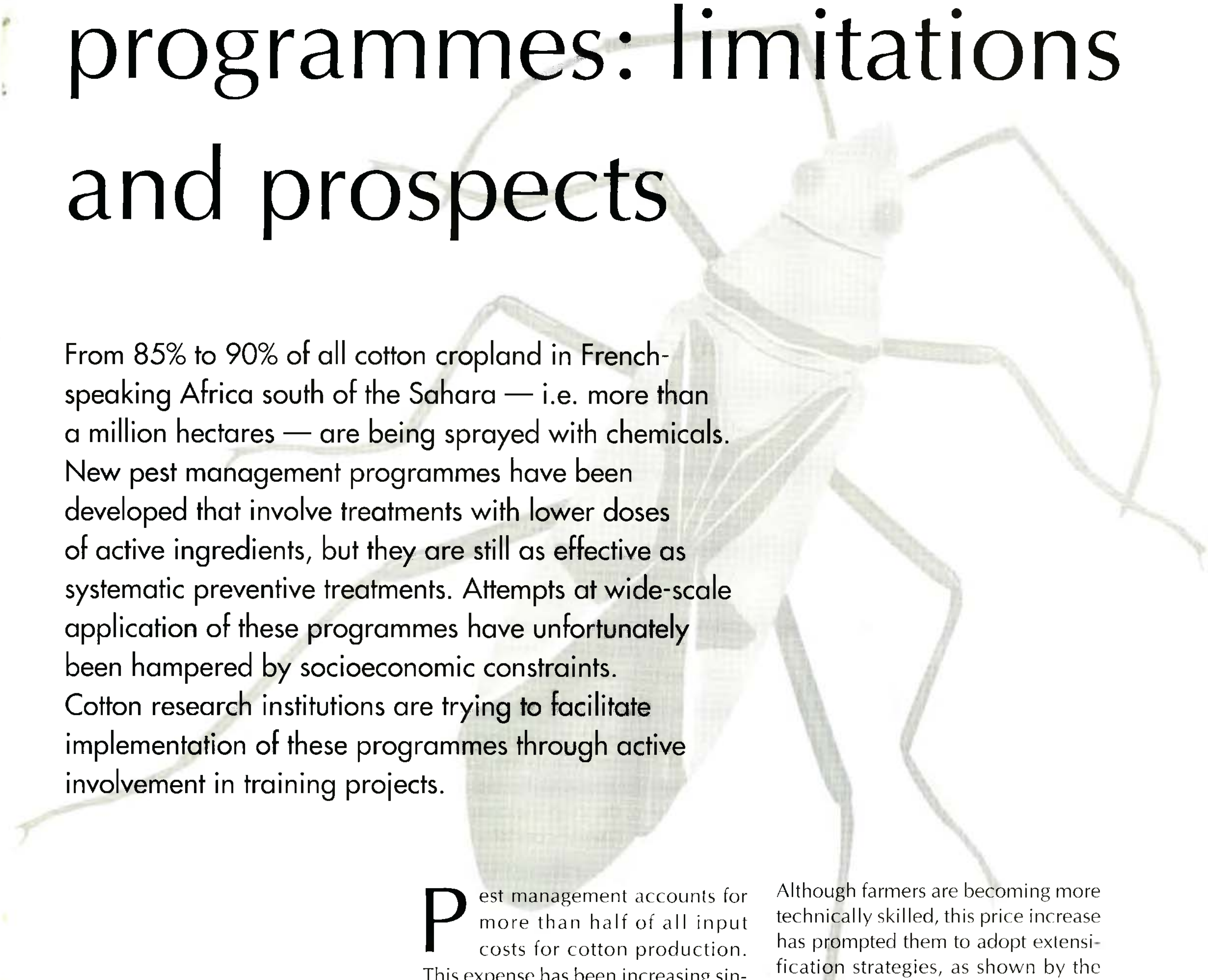
2. New cotton protection programmes: limitations and prospects



From 85% to 90% of all cotton cropland in French-speaking Africa south of the Sahara — i.e. more than a million hectares — are being sprayed with chemicals. New pest management programmes have been developed that involve treatments with lower doses of active ingredients, but they are still as effective as systematic preventive treatments. Attempts at wide-scale application of these programmes have unfortunately been hampered by socioeconomic constraints. Cotton research institutions are trying to facilitate implementation of these programmes through active involvement in training projects.

J. CAUQUIL, M. VAISSAYRE
CIRAD-CA, BP 5035,
34032 Montpellier Cedex 1,
France

Pest management accounts for more than half of all input costs for cotton production. This expense has been increasing since the withdrawal of subsidization (on fertilizers and pesticides) in 1992 and the devaluation of the CFA franc in January 1994. In addition, the producer price for seed cotton has dropped and the pesticide distribution has been privatized. This has had some surprising effects on prices, e.g. in Benin (1993) where the per-hectare treatment cost was fourfold higher than with products purchased abroad.

Although farmers are becoming more technically skilled, this price increase has prompted them to adopt extensification strategies, as shown by the excessive lowering of pesticide dosages for crop treatments. Pesticides are bought at a fixed per-hectare price and usually on credit. Moreover, to reduce expenses, farmers often deliberately underestimate the area they actually crop, and spray their fields with overdiluted mixtures or reduce the number of treatments. Surveys conducted in Burkina, Cameroon, Côte d'Ivoire, Mali, Togo, etc., highlighted that farmers do not comply with recommendations put forward by extension agencies, instead they adapt them to their own financial situations.

Training and technical consultancy on cotton cropping are increasingly provided through village community organizations — this reduces the need for a high number of technical field staff whereas the role of supervisory agents from these organizations is essential.

Pest management programmes adapted to different situations

Cost-effective and environment-friendly pest control solutions have now been developed. However, farmers have to be trained on using these new techniques. Standard cotton pest management involves four to six prescheduled ultra-low volume (ULV) treatments (i.e. 1-3 l/ha of prepared product, depending on the country). The first treatment is carried out 45-60 days after sowing, with subsequent treatments every 14 days.

In each country, this standard programme has been streamlined such that pesticide treatments are adapted to farmers' technical skills, the social environment, the crop-yield potential and pest and disease conditions.

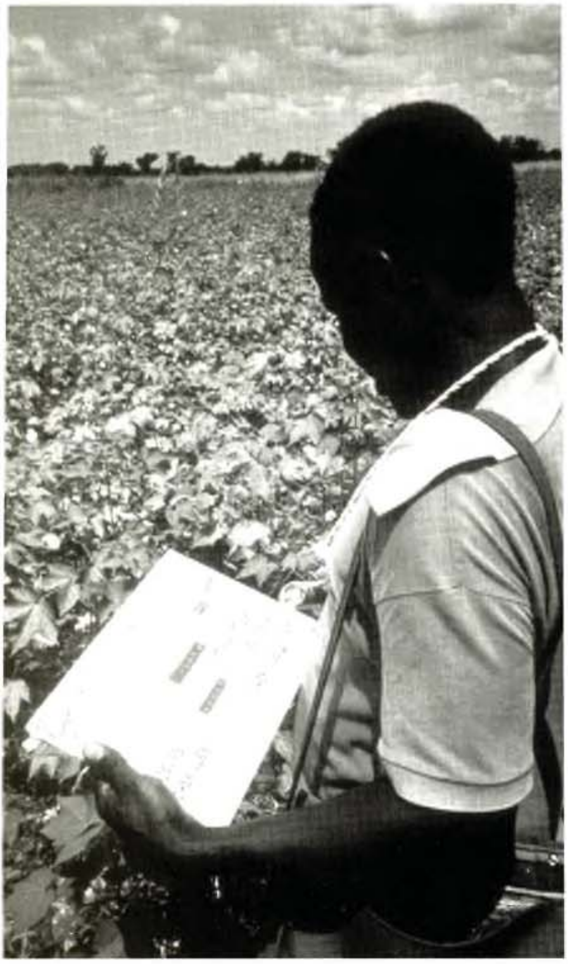
Staggered-targeted control has been recommended for the northern part of the cotton aera, where annual rainfall is less than 1 000 mm and exocarpal bollworms *(Helicoverpa armigera, Diparopsis watersi)* are very common (DEGUINE *et al.*, 1993). This programme involves a series of six treatments (on average), conducted on a 14-day basis, with low doses of one or two active ingredients. Infestation levels of the main pests are checked 7 days after each treatment: bollworms susceptible to pyrethroids; *Syllepte derogata* and mites susceptible to organophosphorous acaricides; *Aphis gossypii* and *Bemisia tabaci*, sucking insects susceptible to organophosphorous aphicides.

It is difficult to assess outbreak levels in the region infested with the endophagous bollworms *Pectinophora gossypiella* and *Cryptophlebia leucotreta*, and intermediate control programmes are thus used. There is about 300 000-350 000 ha of cotton cropland in this zone (30-35% of the overall area controlled).

Binary mixtures of a pyrethroid and an organophosphorous acaricide (at low doses), when they have a potentiation effect, could be recommended in areas where *Syllepte* and bollworms are both present (CAUQUIL & VAISSAYRE, 1994). For instance, with cypermethrin and triazophos blends, the standard doses of 30 g/ha for cypermethrin and 150 g/ha for triazophos could be reduced to 15 + 75 g/ha, respectively. If pest populations are high, an additional treatment has to be added 7 or 14 days after the first scheduled treatment. Extension agencies in Cameroon have opted for this latter solution whereas the first one has been adopted in Benin, Burkina and Mali.

A mixed programme is being tested in Côte d'Ivoire, including threshold-based treatments at the beginning of the crop cycle, calendar scheduled

Data sheet for pest counts.
Photo CIRAD UREA



Counting crop pests with a pegboard in Burkina.
Photos CIRAD-UREA

treatments to control bollworms (exophagous and endophagous) and optional additional treatments, depending on observed levels of sucking insects and mites.

Intermediate control programs are of considerable interest in terms of reducing risks, as treatments are prescheduled. Moreover, this provides an efficient way of training farmers on how to assess pest infestation levels and determine what type of product and dosage is most suitable under the prevailing conditions.

With this training experience, farmers could later switch to threshold-based treatments. Attempts at promoting widespread use of threshold interventions in Notsé (Togo; 1989-1991) and Garoua (Cameroon; 1992) revealed that a transition phase is needed to give farmers time to master this new strategy.

Pests, crop damage and treatment thresholds

Farmers generally consider that all insects are pests, without perceiving that some insects are beneficial. SIGRIST (1992) found that Cameroonian farmers separate insects into two groups, i.e. those that crawl (caterpillars, white worms, etc.) and fly (butterflies and bugs). They act when crop damage is visually obvious: withering (e.g. *Fusarium* wilt), virus diseases (mosaic virus), rolled leaves due to *S. derogata,* and shrivelled leaves after attacks by sucking insects are all considered to be more serious than outbreaks of endocarpal bollworms, for instance, which are not externally visible.

Insects are well perceived in terms of the damage they cause, e.g. aphids and honeydew, bollworms and abscission of fruiting organs or boll perforation. However, farmers should be trained on mites, mirids, vectors of biologically transmitted diseases.

Pest infestation levels are assessed from specific-sized samples (generally 25 plants/unit plot) by counting the number of pests or noting the damage they have induced. These estimates mainly apply to mites, sucking insects, leaf-eating caterpillars and bollworms.

As mites are very tiny, outbreaks are evaluated in terms of damage they cause. Curative treatments should be undertaken once the first leaf damage is observed and related with weather conditions, as mite populations can expand very quickly.

Aphid colonies are generally found on terminal shoot leaves. At the beginning of the growth cycle, infestation levels can be evaluated on the basis of the number of plants with shrivelled leaves — a sign of aphid attacks.

Whitefly *(B. tabaci)* populations are estimated by counting adults very early in the morning on terminal shoot leaves or nymphal forms with a magnifying glass. These nymphal counts are done on leaves chosen according to specific criteria, such as number, area, position, and growth stage.

The leaf roller *S. derogata* is the most commonly reported leafeating caterpillar. Outbreaks are assessed by counting the number of worms on each plant, which is preferred over counting rolled leaves (or plants with rolled leaves), as these symptoms are persistent.

Exophagous bollworms (*H. armigera, D. watersi, Earias* sp.) are visible on the external parts of plant organs, and population growth can be evaluated by worm counts. In contrast, outbreaks of endophagous bollworms, which occur on more than one-third of all cotton cropland, can only be assessed by random cracking of fruiting bodies.

Cotton fields are surveyed weekly, with observations noted on data sheets (Cameroon) or pegboards (Burkina, Benin, Chad). One major advantage of pegboards is that they can be used by illiterate scouts, whereas observations have to be written down and summed up on the data sheets. Nevertheless, data sheets are of considerable interest as the quality of the monitoring work can be evaluated, data can be compared for a given zone to help in decision making, and nomographs can be used when the impact of the pest varies at different crop stages. The latter occurs with aphids, which are considered to be much less threatening in the middle of the crop cycle than at the beginning or the end — treatment thresholds therefore vary with the extent of risk.

Pest-specific treatment thresholds are determined on the basis of economic, climatic, biological and agricultural factors. They generally do not vary markedly between countries.

It is crucial to conduct treatments immediately after the threshold has been reached, and the choice of pesticide and dose is also important. Special measures should be taken during serious pest outbreaks, especially for *H. armigera*.

Toxicant monitoring

African farmers' conception of pesticides is highly complex: they are considered as poisons with a mythical aura (a product from the "modern" world) which can also have other uses (for fishing, hunting, etc.). Training is essential as many farmers are unable to decipher and interpret pesticide labels, or they do not abide by the instructions (which, in any case, are often not sufficiently detailed).

Pesticide packaging has to be well designed to avoid pollution problems. Each kind of packaging has advantages and drawbacks, depending on the ultimate use. Metal drums are solid and enable storage of small volumes of product, but it is difficult to pour out the contents in small batches (tap, funnel, scoop). In addition, these drums are commonly reused, e.g. as distillation equipment, for transporting water, roofing material and kitchen use. Extension agents can easily monitor drum recycling as they are not supplied in large quantities.

Plastic cans are readily stored, transported and handled. Farmers mainly reuse them to hold edible liquids or fuels. The results of a survey carried out by SIGRIST (1991) of 73 villages in Cameroon indicated that 19% of these containers are destroyed after use, 18% are reused for fuels, and 63% for food products (water, oil, honey, cowpeas). In Côte d'Ivoire, CHEYDA (1991) noted that all plastic cans were recycled after rinsing, whereas metal containers were destroyed or discarded.

Metal or heavy-duty single-dose containers reduce handling and the risks of making treatment dosage errors, but the per-litre purchase price is higher. As these containers are relatively small, they almost never reused.

In French-speaking Africa, "English packs" — including different formulations, instructions in the local language, gloves, and sometimes even a mask — are never used. The problem is that farmers fields are often larger than officially declared and these packs are designed for treatment of a specific surface area.

VLV spraying equipment.
Photo CIRAD-UREA

Various types of pesticide packaging.
Photo CIRAD-UREA

Pesticide storage in a cotton extension company warehouse.
Photo CIRAD-UREA

Farmers often do not comply with the precautionary recommendations, especially concerning protective clothing. In Côte d'Ivoire, a survey by CHEYDA (1991) revealed that all control operators wore short-sleeved shirts or t-shirts, but 20% were wearing shorts; only 5% wore boots, 10% laced shoes, 20% sandals, and 65% were barefooted; finally, 90% were bareheaded. All questioned operators stated that they washed their hands, but usually did not change their clothing after a treatment. In Cameroon, SIGRIST (1991) noted that control staff did not eat, drink or smoke during treatments; they sometimes protected their heads, took the wind direction into account and washed completely after control operations.

Training aids

Training is not a top research objective, but it is essential for efficient implementation of research results.

For extension purposes, a considerable effort has to be made to train field workers on new crop protection programmes while highlighting their economic impacts.

Control scouts have to be highly observant to ensure the efficacy of these new pest management programmes. These scouts choose representative samples, and carry out a series of counts to assess populations of the main pests. The technician that does this work should also aim at training head farmers or members of their families. In Cameroon, control scouts are often youths who have just finished their schooling. They are paid by the local village communities for the task of monitoring an area of about 40 ha (cropland concentrated in blocks). In western Africa (Benin, Burkina, etc.), cropland is relatively scattered and farmers do not wish to have their fields surveyed by external agents. It is therefore necessary to train a member (preferably literate) of the farmer's family.

The scout always has to be attentive and his job is repetitive and difficult on account of the morning dew and heat during the day. The training supervisor has to keep checking the trainees' work, at least during the apprenticeship (in Cameroon, the head control staff regularly collect copies of the scouts' data sheets). To warrant their positions, these supervisors have to have a high level of technical and training skills. In addition, the "neighbouring extension" phenomenon can be used at opportune times, as farmers are often highly receptive to innovations being tested nearby.

Training steps

The treatment threshold concept, based on the assessment of pest damage from an economic viewpoint, should be stressed at the outset when training farmers on new pest management programmes. This represents a new intellectual challenge for many farmers who might, for instance, be hesitant to begin a treatment when they detect only five *H. armigera* caterpillars in a sample of 25 cotton plants. Even a few of these larvae can cause crop damage — it can be difficult for them to comprehend the treatment cost/crop loss

Staggered-targeted control training in Benin.
Photo CIRAD-UREA

trade-off. In this situation, theories concerning beneficial fauna and environment-friendliness should not yet be put forward. This initial step should be handled by local training agencies.

Assessment of infestation levels

The representative sample of 25 cotton plants should be chosen randomly within the field to be protected. The main problem is in predetermining uniform cropfield units to be sampled. This choice is generally made by the training agent through a rough assessment of each field plot (2 ha maximum). Large cropfields are divided up (e.g. in Cameroon, one sample for four 0.25 ha plots in a block design).

The scout then carefully examines the collected sample and assesses infestation levels of the main pests: mites, sucking insects, leafeating caterpillars and bollworms. This agent must be able to recognize all of the life-cycle stages for each crop pest as well as the damage they cause. These counts can be hampered by poor climatic conditions or the vegetative growth of the cotton plants.

Treatment decisions

Decisions to begin treatments are made when the threshold has been surpassed. When the scout is using a pegboard, the threshold is surpassed when the peg (inserted successively in the pegboard holes after sampling each unit) is located in the "red zone", which also shows the most suitable formulation to be used against each specific pest.

Theoretically, when data sheets are used, treatment thresholds can be adjusted on the basis of the nomograph results, but this would require further training on such advanced technical skills.

Formulation and treatment choices

Control scouts are responsible for choosing the most suitable pesticide formulation and dosage. In many countries, the colours of labels on the pesticide products facilitate choice-making as they correspond to the pegboard or to the pest identification guide. The training staff have to be highly attentive as there are many possible sources of error.

Spraying techniques vary according to the pest to be controlled. Spraying is directed at the most affected area, i.e. the underside of leaves for mites and sucking insects, plant tops for bollworms, and peripheral leaves for leaf-eating caterpillars.

Training methods

Local extension agencies and young literate scouts are still essential components of the new pest management programmes. Head farmers have to be trained to ensure the successful extension of these programmes. SCHWARTZ (1993) estimated that 13-15% of Burkina cotton producers are literate (8% of other farmers). DJIMRAOU (1993) reported that 25% of Malian cotton producers can read and write Bambara or French. Training methods have to be simple and illustrated, and adapted to this slowly-changing situation.

The training focus of research is mainly on identification of crop pests and the damage they cause. In Cameroon, ASFOM (1994) recommended setting up a network of untreated plots to help in training scouts and field technicians and to monitor pest and disease levels.

Extension agencies have access to many training aids: slides, videos, illustrated leaflets, technical posters, etc. Slide shows have been designed to show how VLV treatments (DEGUINE & ASFOM, 1990), and staggered-targeted control operations (AMIOT *et al.,* 1992) are organized. These documents complement practical field sessions, involving entomologists, aimed at presenting different strategies to training agents. Scientists provide them with tools to help them in understanding pest management principles and gaining skills in this field: pest quantification to determine treatment thresholds, collection periods, active ingredients and doses. Trained staff are then responsible for training farmers and scouts on data collection, treatment decision-making, conducting treatments, sprayer handling and maintenance.

Research organizations are not yet involved in specific training on pesticides: storage, handling, hazards, or their effects on target pests and beneficial organisms. Audiovisual documents designed for this purpose could enhance toxicant monitoring, reduce pollution and increase treatment efficacy.

Conclusion

This new pest management concept addresses economic and ecological concerns, i.e. improving the cost-effectiveness for farmers while being environment-friendly. The role of scientists is to develop pest-specific ecoregion techniques that are adapted to different pestmanagement ecoregions, while assisting extension agents in their task of informing and training farmers.

Staggered-targeted control has been widely used, with promising results. In Cameroon, since 1990, thousands of ha were controlled by this strategy, with savings of as much as half the costs required for standard control while still achieving the same crop yields. Benin, Burkina and Mali are currently at the pre-extension stage concerning this new approach. However, there is a higher risk of making the wrong decision with these new pest management programmes. Treatment decisions are based on scouts' assessment of infestation levels, but crops can be quickly and seriously damaged once the threshold is surpassed. Training of scouts, field supervisors, and heads of farmers' organizations should involve informing and giving them responsabilities, while carefully presenting them essential guidelines. This could be efficiently done by setting up annual 1-2 week training sessions in different countries, with an introductory session followed by yearly brush-up courses. This training could be partially funded by village associations. Extension of these new techniques should be done gradually in order to evaluate their impacts on the ecological balance between pests, beneficial arthropods and host plants.

The first extension experiments revealed that the main problems encountered are socioeconomic, not technical, thus highlighting the importance of human aspects of agricultural development.